How Students Collaboratively Write using Google Docs

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Abstract
Writing collaboratively is increasing in many professions, including among college students. Students are writing many assignments collaboratively, learning as they go. Writing collaboratively, however, takes coordination and awareness of who has done what. We offer a new tool, DocuViz, which displays the entire revision history of Google Docs, showing more than the one-step-at-a-time kind of snapshot currently available in Docs and Word. Using **DocuViz**, we analyzed 99 students' reports from a Project Management class and found it to reveal interesting patterns of collaborative writing. We believe this tool would be useful not just for **researchers**, but also for the **authors** themselves and **instructors**.
Keywords: collaboration; writing; college student; visualization; Google Docs
Citation: Wang, D., Olson, J.S., Zhang, J., Nguyen, T., Olson, G.M. (2015). How Students Collaboratively Write using Google Docs. In *iConference 2015 Proceedings*.

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1 Introduction

Collaborative writing is common and important in many professions (Lowry, Curtis, & Lowry, 2004). An earlier study showed that 85% of university writing and company reports are collaboratively written (Ede & Lunsford, 1990). In educational settings in particular, collaborative writing helps with students' writing skills.

But collaborative work requires authors to be aware of what each other is doing or has done so they can coordinate (Schmidt, 2002). To enhance the collaboration awareness, many features and systems have been proposed, and researchers found, in general, that features allowing authors to track changes and see the revisions can help (Michailidis & Rada, 1996).

Today, both Word and Google Docs offer views of recent changes. However, co-authors likely need a richer view over time to see who is working in which part, how various parts relate, etc. (Ball & Eick, 1996). By seeing a bigger picture, authors can better understand co-authors' intentions, more easily reach common ground, and produce higher quality (Noel & Robert, 2004).

There are two good examples of richer visualizations that inspire our work. Voinea and his research team designed CVSscan to visualize the software code's evolution using the code repository data (Voinea, Telea, & Van Wijk, 2005). As shown in Figure 1, CVSscan visualizes individual lines of code with each revision as sections of the column with the horizontal direction indicating time. Additions are shown in light blue, deletions in red,, modification in yellow and constant in green. This shows the changes over time, but does not know who made them.

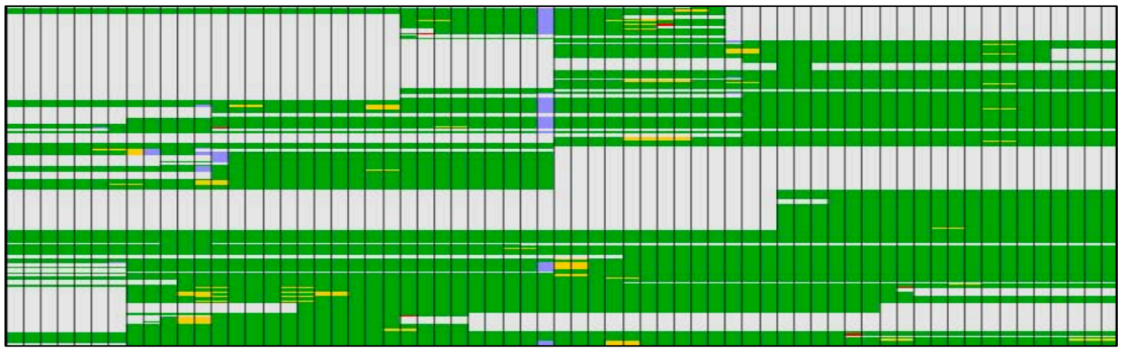


Figure 1. The CVSscan visualization

The second inspiration comes from *HistoryFlow,* created to show how articles in Wikipedia change over time and who the authors are (Viegas, Wattenberg, & Dave, 2004). It uses columns to indicate each revision of a document and different colored sections to represent size of changed content by different authors. In other words, it shows who did what, how much, where and when. The visualization rules are illustrated in Figures 2, and a resulting visualization is shown in Figure 3.

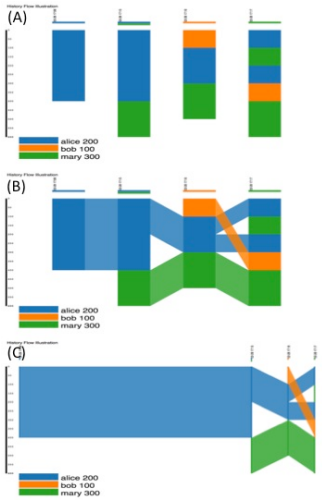


Figure 2. Representation of who did what when in HistoryFlow. (A) indicates how much is written or deleted in different revision columns, (B) shows the mapping of changes or stability over time, and (C) shows this same view scaled by time.

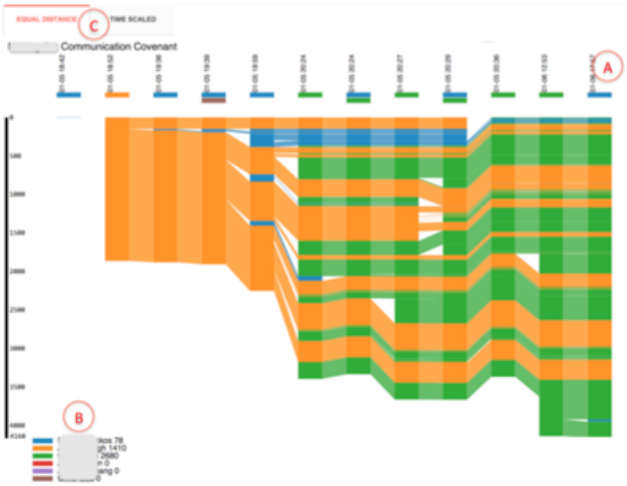


Figure 3. A visualization of a document's development over time, time moving from left to right. (A) shows who is in each time slice, (B) shows the number of characters from the final document contributed by each author, and (C) shows two tabs for the ordinal view and the time-scaled view.

2 Research Questions

This work introduces a new tool that visually presents the collaborative written document's evolution. With the help of this tool, we address the following research questions:

1. Can **DocuViz** help reveal patterns of collaboration in document writing
2. How do college students collaboratively write using Google Docs
3. (Eventually) What patterns of collaboration correlate with quality

3 Methodology

Our study uses DocuViz on a corpus of 99 assignments produced by student teams in three years of a Project Management class.

3.1 DocuViz

DocuViz is a general-purpose visualization system applicable to any document with a revision history in Google Docs. Its architecture, however, allows easy generalization to documents generated on other systems such as Wikis and Microsoft OneDrive. As shown in Figure 3, **DocuViz** shows who did what when, detailed in the figure caption.

The colored bars at the bottom, Figure 3B, show a compilation of the number of characters in the final document that were produced by each of the authors. The two tabs at Figure 3C allow two views, as does *HistoryFlow*, one where the columns are equidistant (shown), and one where they are linear in time, showing bursts of activity and lags. Hovering over the column slice will show the text in that segment, a feature that turns out to be very helpful in analysis.

DocuViz can be accessed at:

docuviz.ics.uci.edu

3.2 Data Source

Our data source is a corpus of 99 documents produced by undergraduates in a Project Management class in a university located in the U.S.. In the class, students worked in teams with 4 to 5 team members. They were required to use Google Docs to share documents with teammates and the teacher. There were four assignments in which students were required to work collaboratively and submit a document for grading:

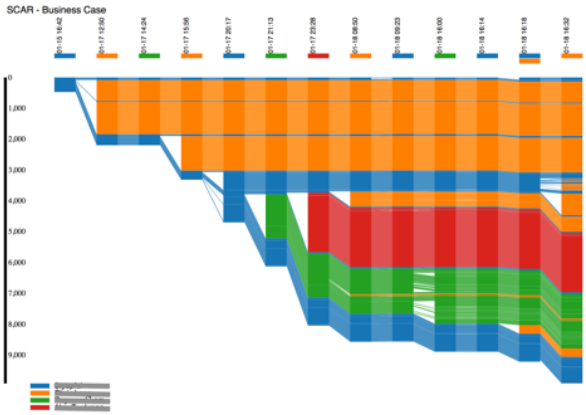
- A Communication Covenant;
- A Business Case;
- A Scope Statement and Work Breakdown Structure;
- The Cost, Quality and Risk Management document. .

4 Preliminary Findings

Because Google Docs allows authors to work simultaneously, we were interested in, among other things, how often and how they worked in this mode. We found that most teams mixed simultaneous and hand-off styles of work. Only 3 of the 99 documents lacked any episode of simultaneous work; in those few it was *all* hand-off. In contrast, in 7 of the 99 documents they *always* worked together, with no solo work. The longest session with more than one person working was 155 min, and in one case, the entire assignment was produced by all team members in 67 min, surprisingly not right before the deadline, but a full three days before it was due.

In addition, we found three patterns of collaboration that students often use while writing their assignments, styles we call “outline,” “example,” and “best-of-each.” These are each illustrated below

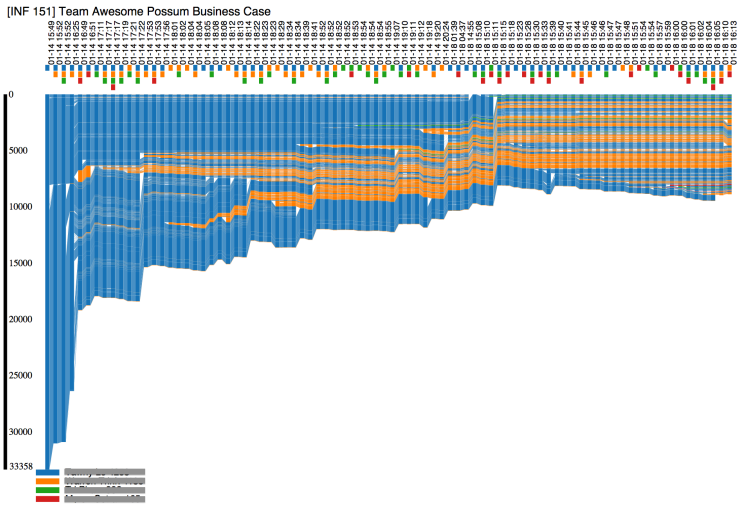
1. **Outline** the assignment and then assign people to head different parts, either implied or directly through commenting.



As shown in Figure 4, the leader (the blue author) wrote a paragraph in the first revision, an outline of the document. Then all co-authors including the blue, the orange, the red and the green wrote separate sections of the document. Most of co-authors did not edit others’ writing except the orange author edited the blue’s work at the last moment. This is an example of the first pattern.

Figure 4. The *outline* pattern

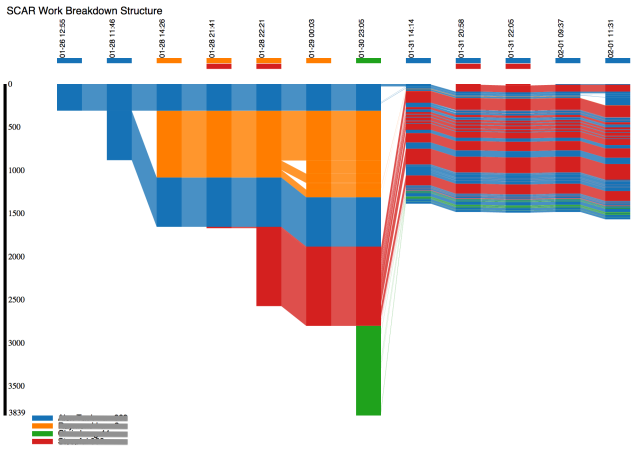
2. Paste in a full **example** (e.g. of a Business case) then maintaining the structure but replacing the example specifics with the specifics of their project.



In this assignment, the students are required to write a business case for their project. As shown in Figure 5, it appears that the most intuitive way for students to write the first time is to find an example of a business case, paste it in and then modify it to fit their own project. That is why in this figure, we can see decreasing trend in the document length, as opposite to the previous figure, in which the document length is almost always increasing.

Figure 5. The *example* pattern

3. Each person on the team creating the whole assignment, pasting them all in the document and then **choosing the best** part from each.



In the Figure 6, we can see four different authors (blue, green, orange and red) contribute almost identical amounts of information at a certain time point. The length of the document then decreased sharply in the next revision. After looking into the content of the document, we can see that the four authors wrote their version of the whole assignment and then collectively chose the best parts from each. As shown in the visualization, the blue and the red have more contribution in the final draft, whereas most of the green and the orange's work is abandoned. This may be driven by the quality of their work or the social dynamics within the group.

Figure 6. The *best-of-each* pattern

This work is ongoing. We are investigating what collaborative patterns lead to quality, and suspect that those teams where they edited *each others' work* are those in which the document read as a whole and sections or points were not left out.

5 Conclusion and Future Work

In sum, we present a new tool, DocuViz, which allows people to see a useful visualization of revision histories of Google Docs. The richer, longer-term view reveals patterns of collaborations in college students' creation of class assignments. We believe this tool is useful in more settings, and not only for researchers, but also for authors and instructors.

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